A New Approach to Photometry for Mixed Resolution Data Sets

Anthony Gonzalez
Lexi Moustakas

PyGFIT: A New Approach to Photometry for Mixed Resolution Data Sets

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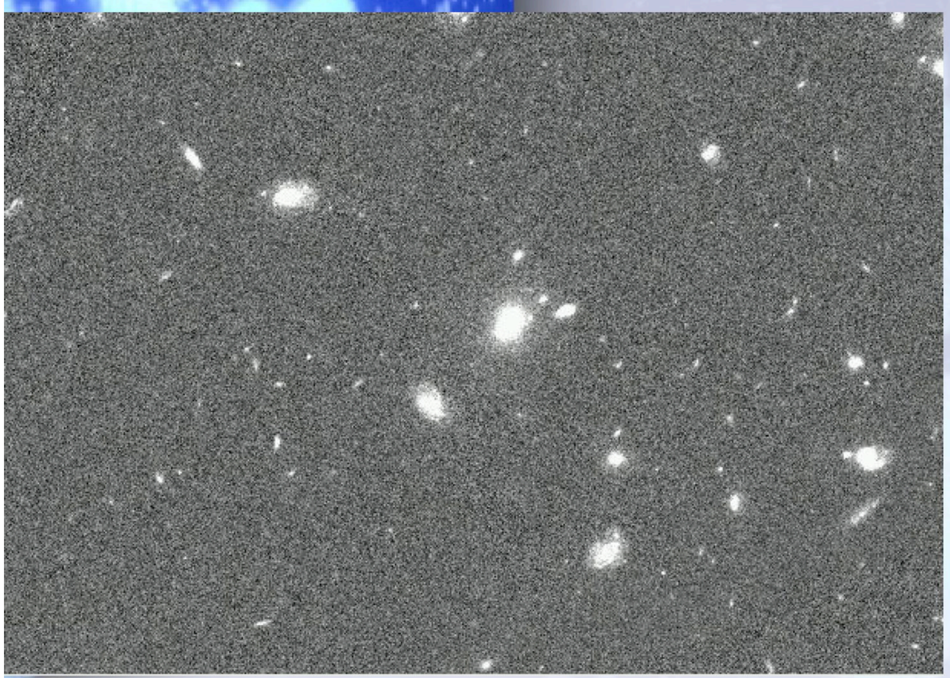
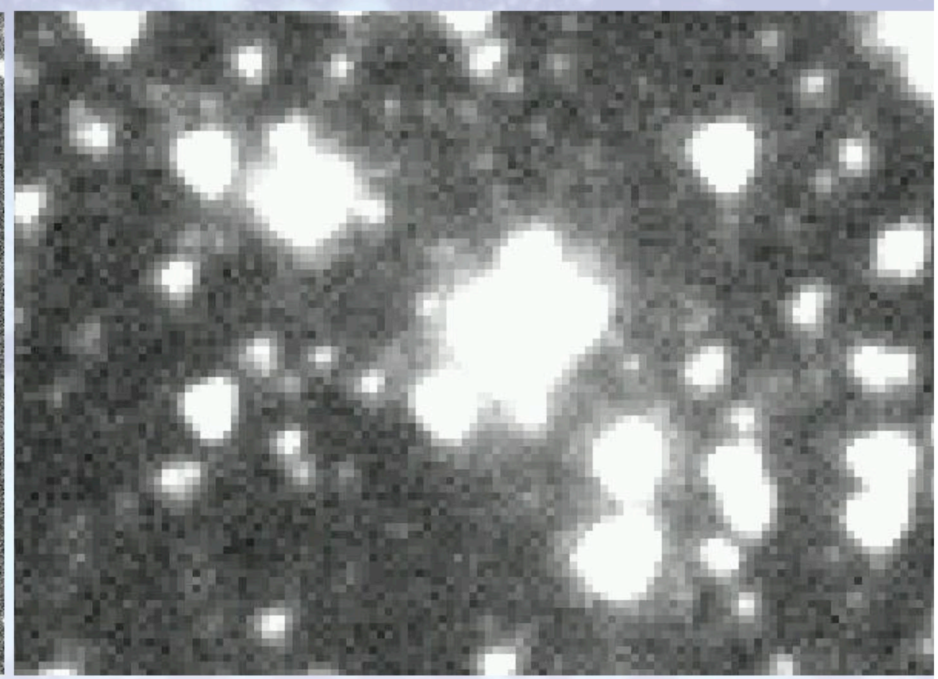
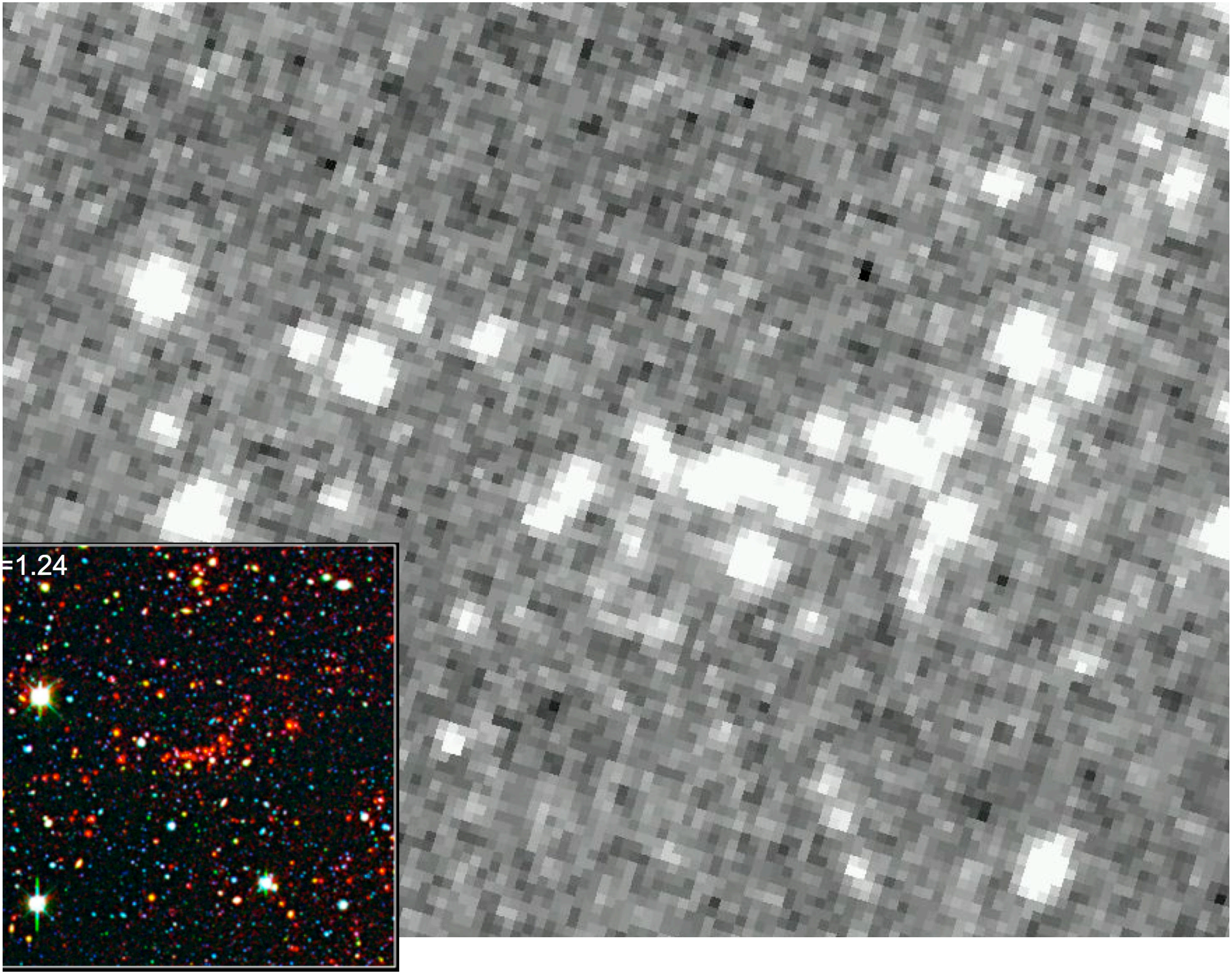
The Question

- How to best measure photometry in different resolution images?



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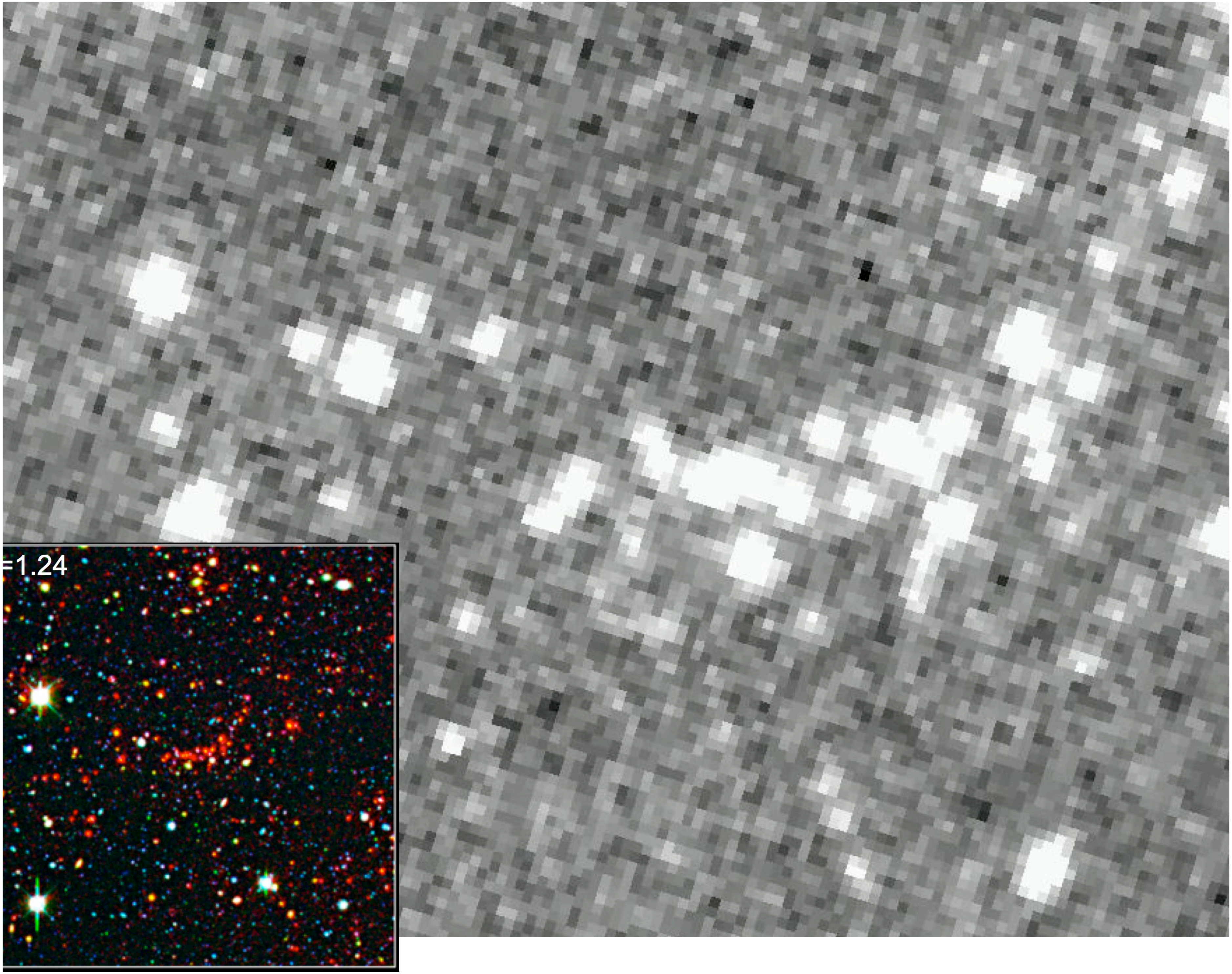
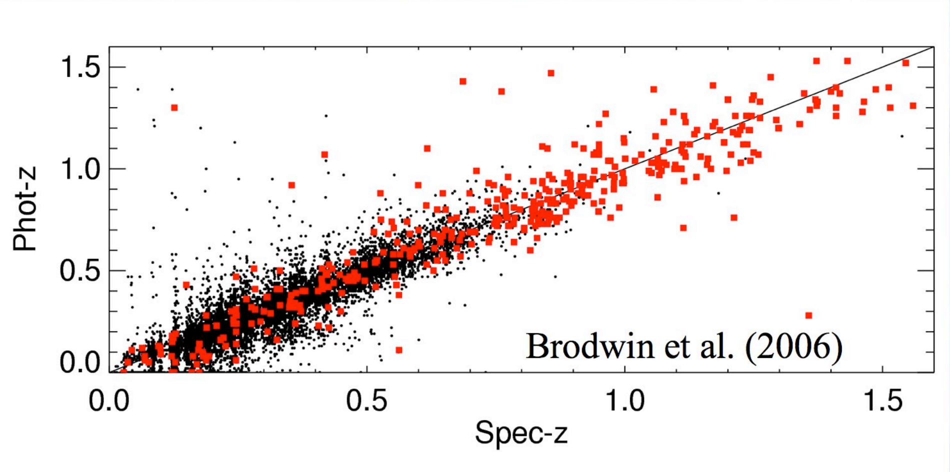
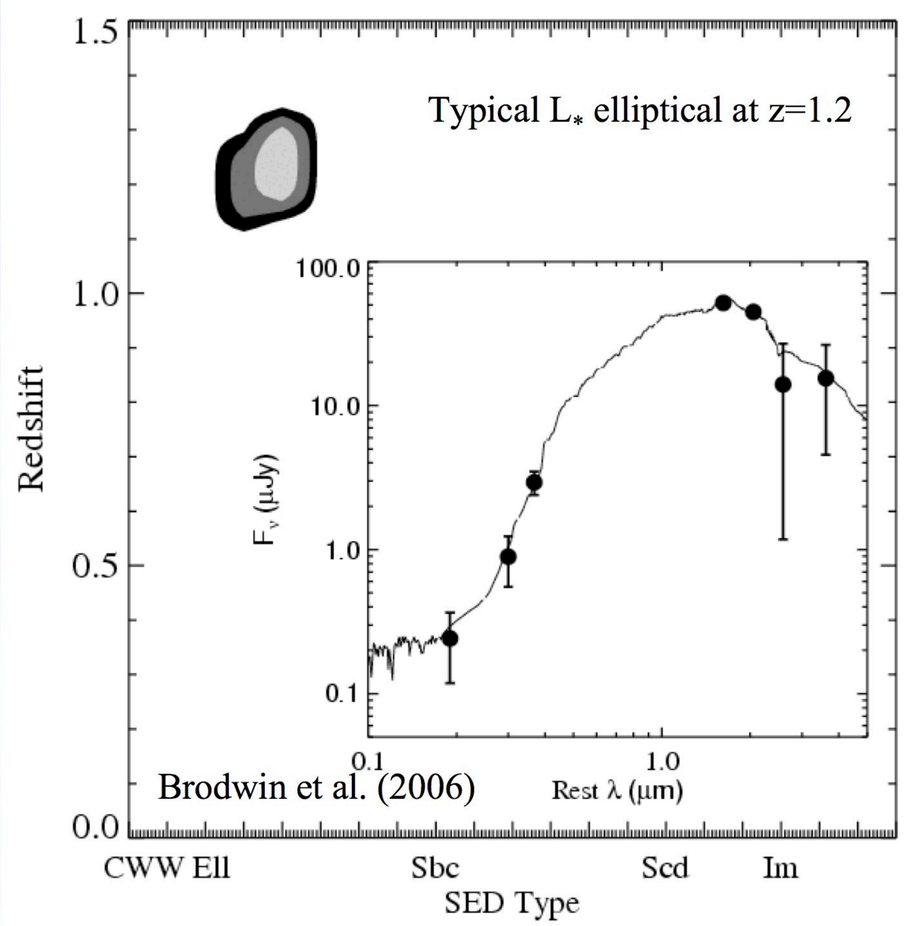

=1.24

Science Drivers

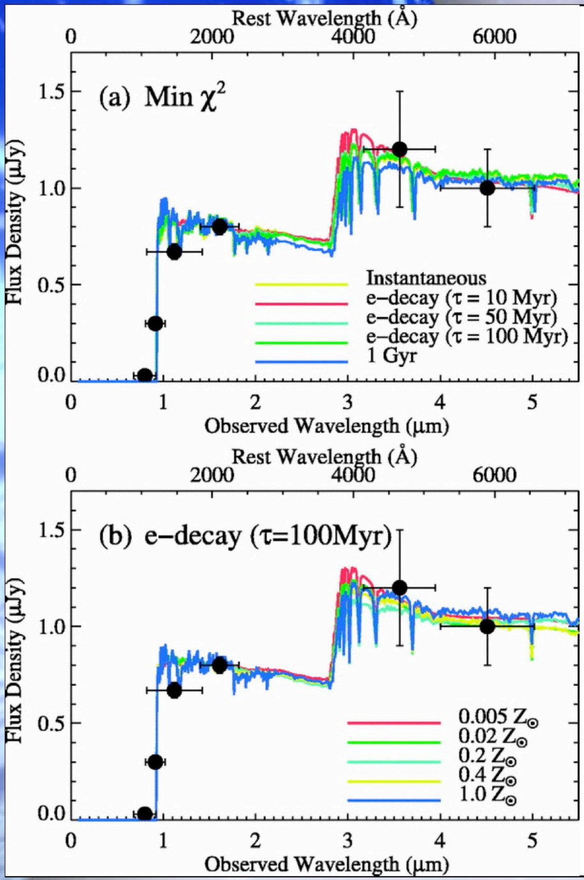
- Spectral Energy Distributions
- Photo-z's
- Cluster CMDs

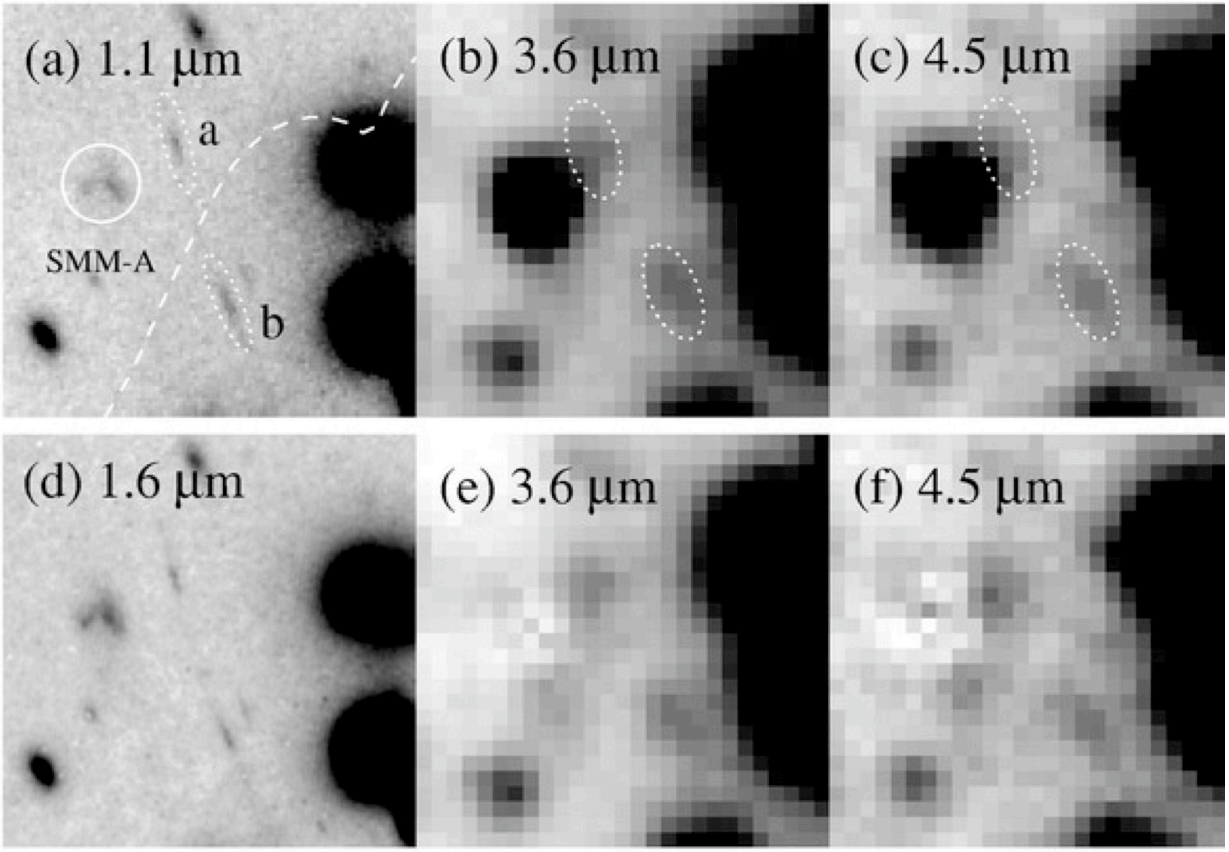




Science Drivers

- Removal of bright foregrounds





Egami et al. (2005)

Science Drivers

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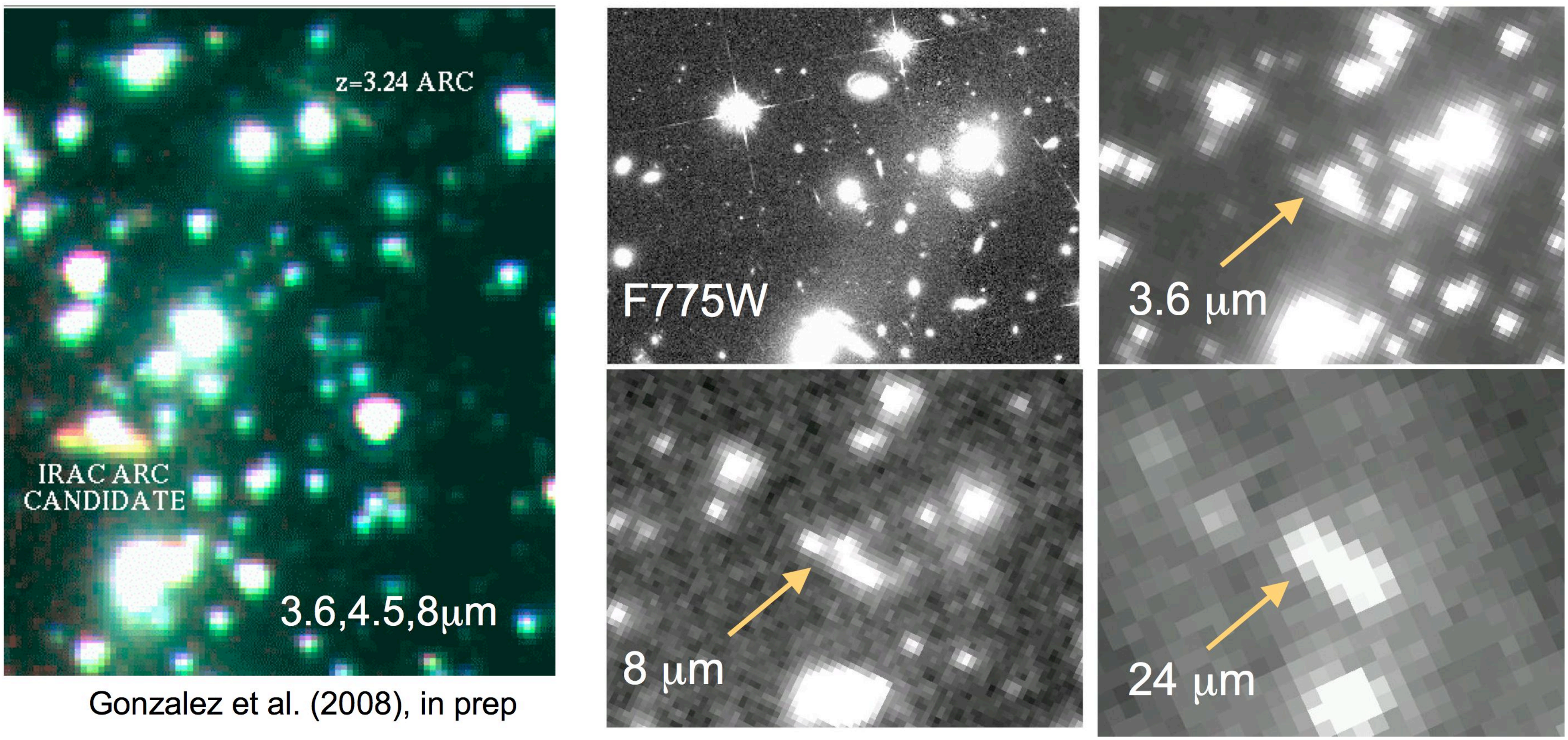

Gonzalez et al. (2008), in prep

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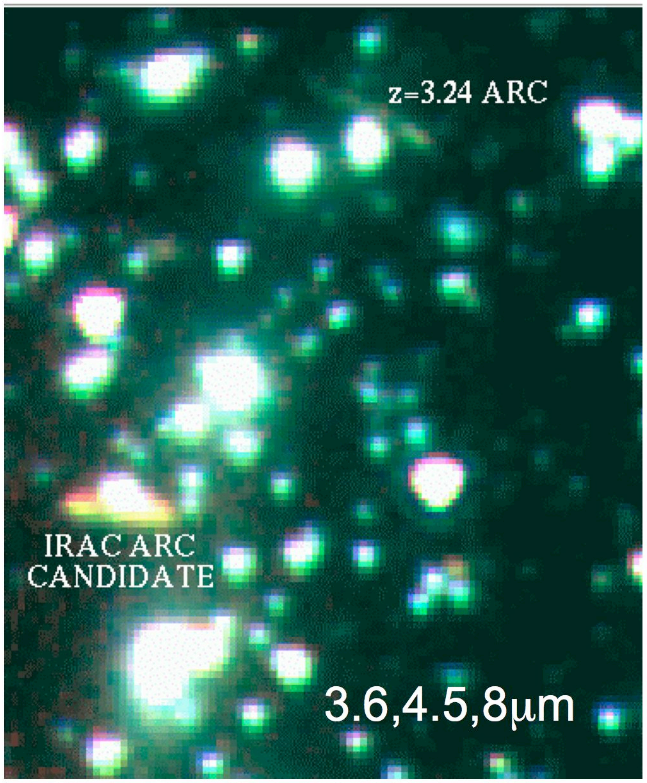

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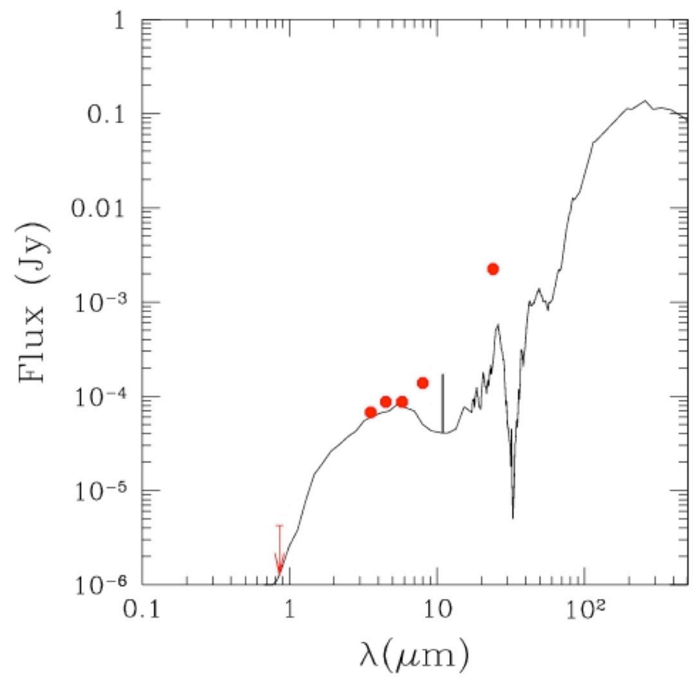

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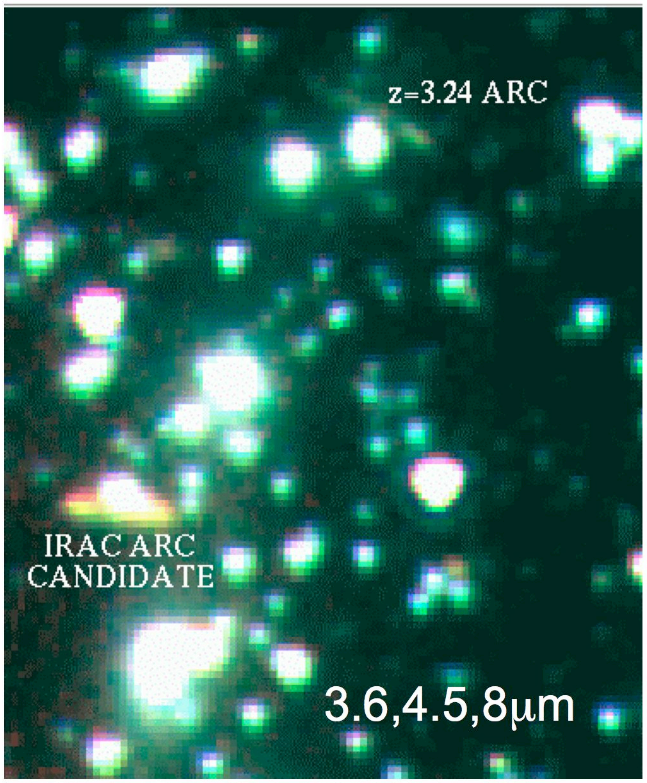

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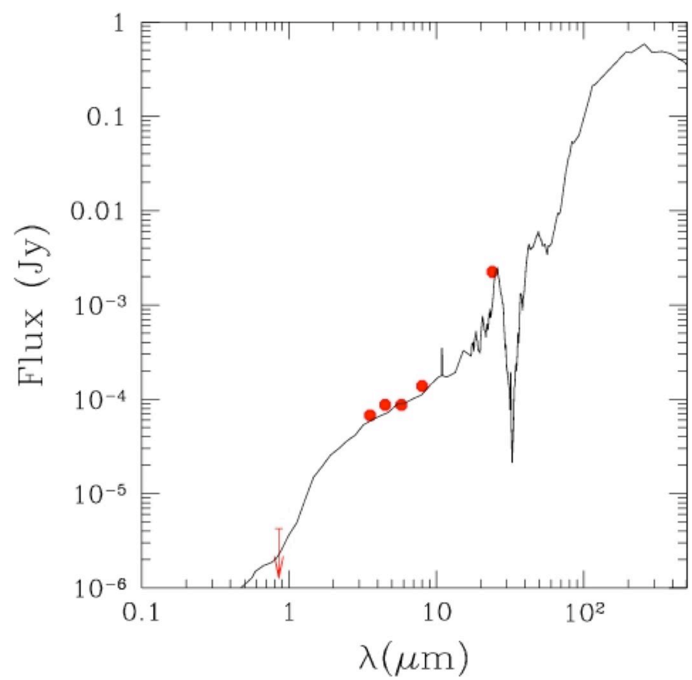
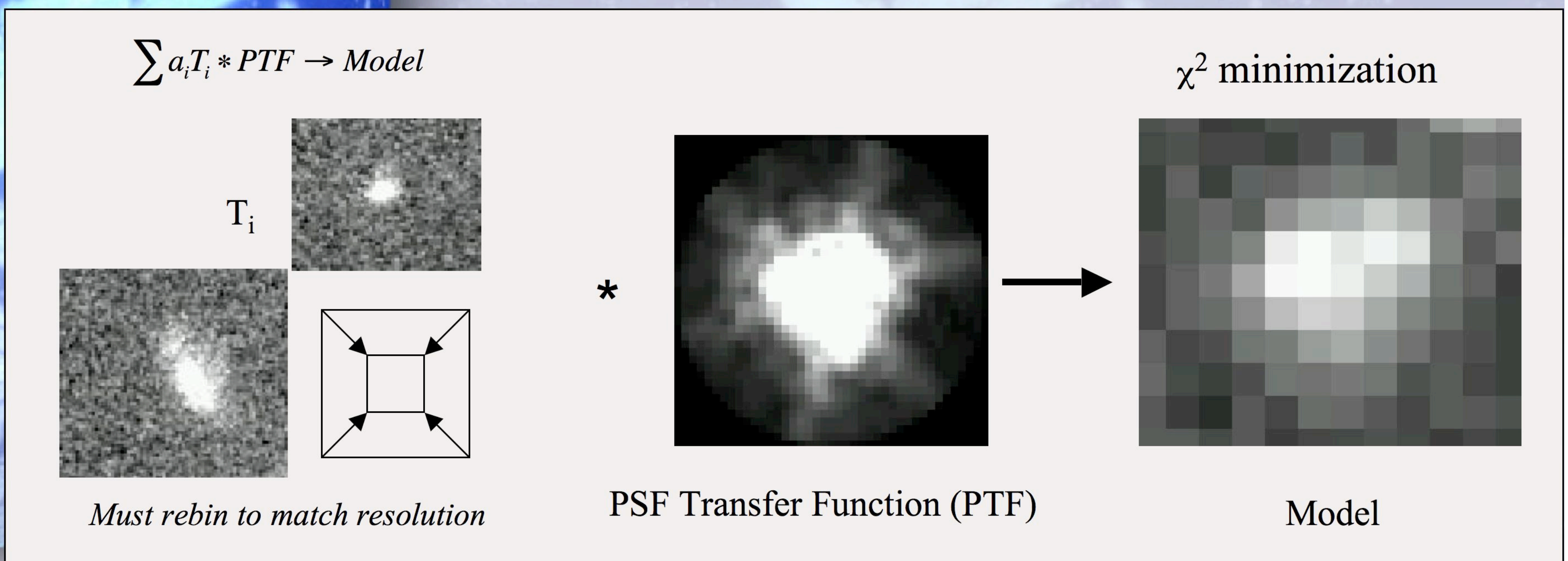


~5x high TIR component than Arp 220

Non-parametric Codes

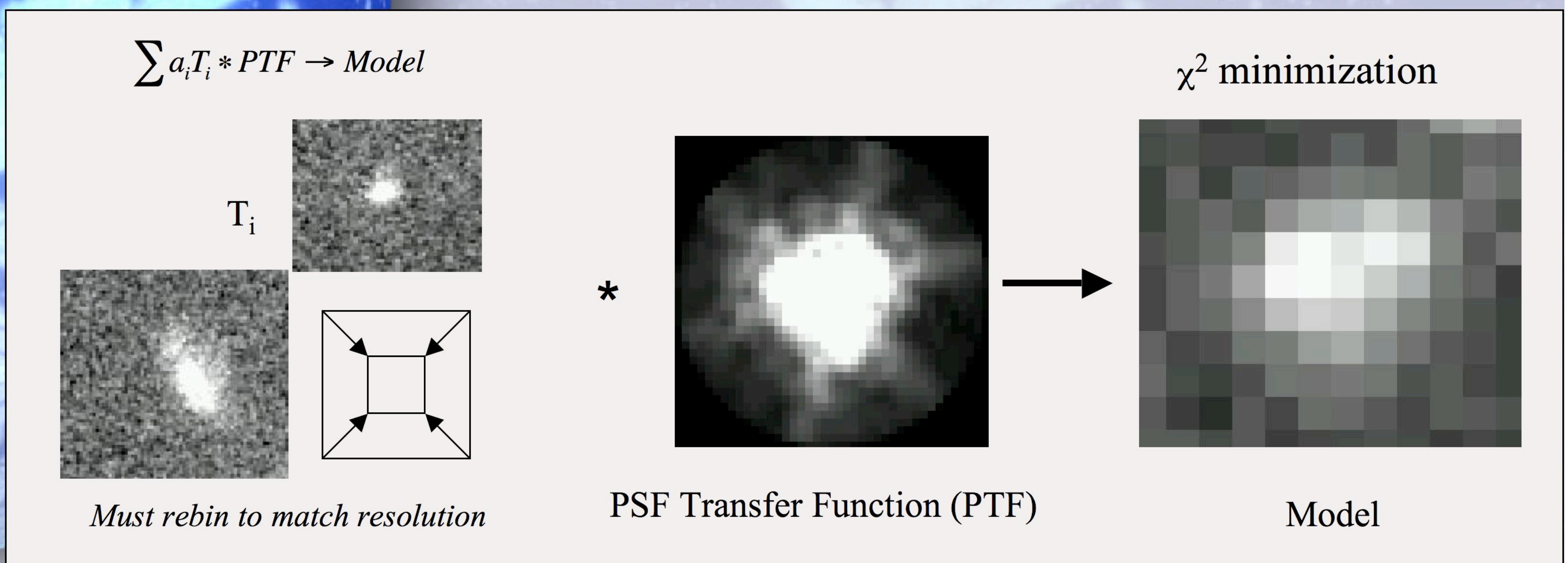
- TFIT
  - Laidler et al 2007
- ConvPhot
  - de Santis et al. 2007, Grazian et al. 2006



Non-parametric Codes

Key Advantage: Direct Comparison of data sets, so minimal assumptions

- ConvPhot
  - de Santis et al. 2007, Grazian et al. 2006

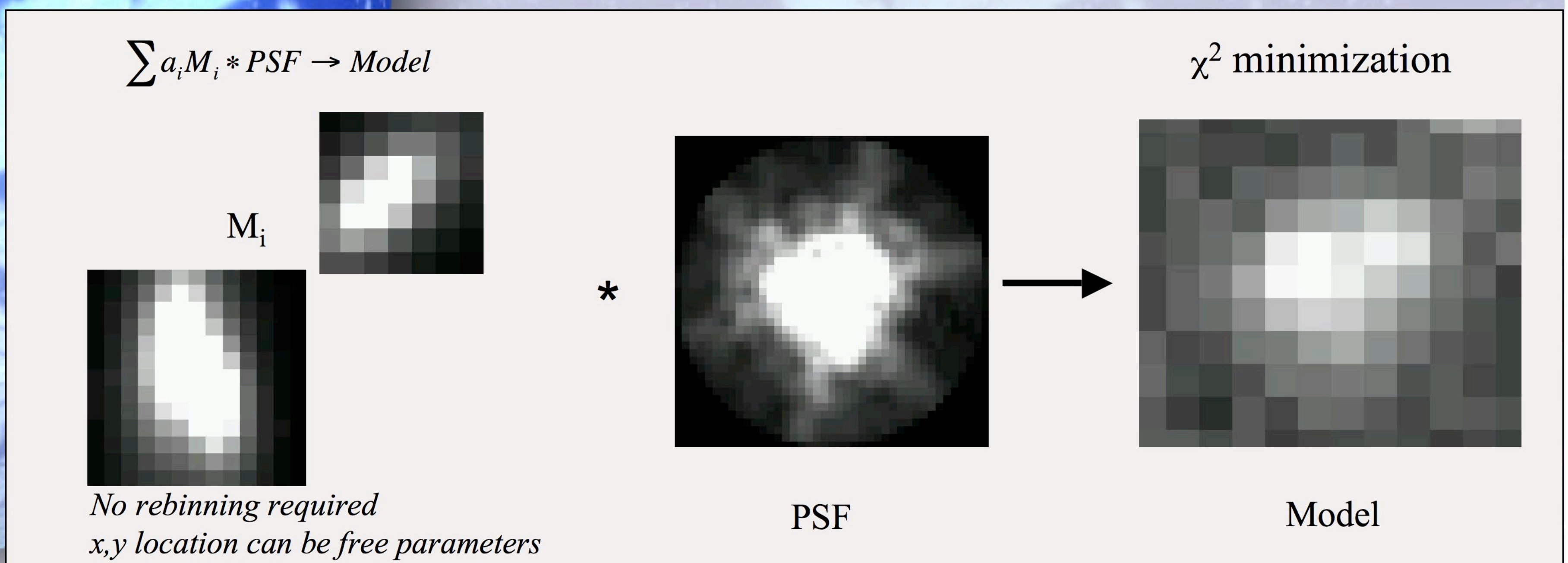


General Considerations

- Limitations
  - High-resolution data must be deep
  - Objects must be well-separated in detection image
- Assumptions and Potential Biases
  - Morphological k-corrections
  - Systematics due to PSF mismatch
- Astrometric and alignment issues
  - Pixelization/Resampling effects
  - Jitter/Subpixel offsets between images
  - Must set images to same orientation and rebin to appropriate resolution

PyGFIT Approach

- General concept similar to TFIT & ConvPhot
- Parametric using galaxy structural models
  - Works with standard quantitative morphology software (Galfit, GIM2D)
  - Can be used with any analytic model



PyGFIT Approach

- Disadvantages
  - Requires galaxy structural models
  - (Reasonable) extrapolation beyond observed profiles
  - Models will not include asymmetric components
    - Irregular galaxies, tidal tails, ..
  - Garbage in ⇒ Garbage out

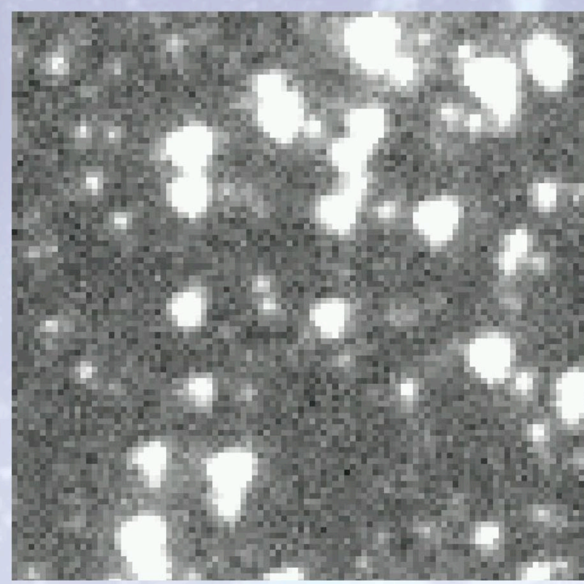
Advantages

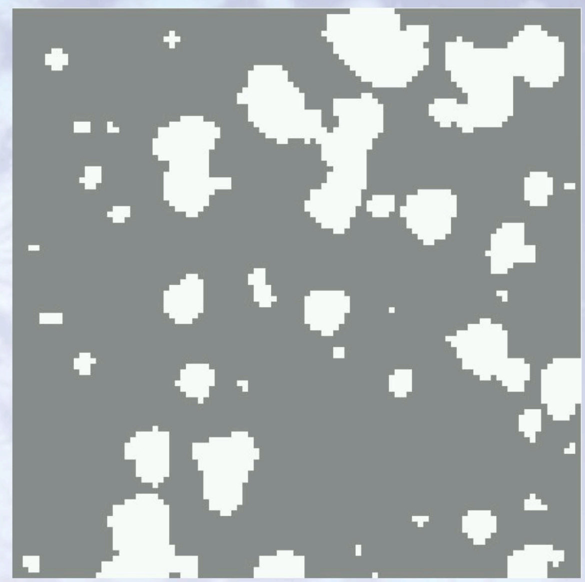
- **Easy to get running**
  - Need: image, rms image, PSF, structural catalog
- **Fast**
  - ~10x faster than ConvPhot (based on specs on ConvPhot web page)
  - Well-suited for large survey fields
- Alignment issues simple
- “Matched” photometry
  - Same model used for high and low resolution images
- Straightforward to simulate uncertainties
- Robust/Stable

- Works near saturated stars
- Can work at somewhat more crowded field levels
  - Sources can overlap in detection image
- Works on image boundaries
- If desired, can fit bulge, disk magnitudes independently

Implementation

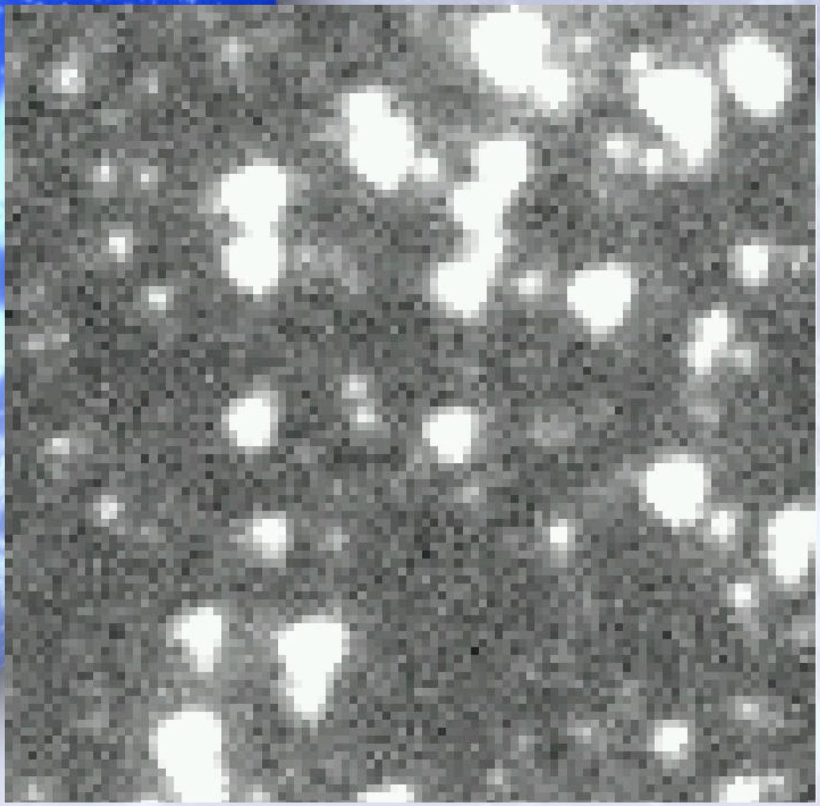
1. Background subtraction & object detection in low resolution image (Sextractor)

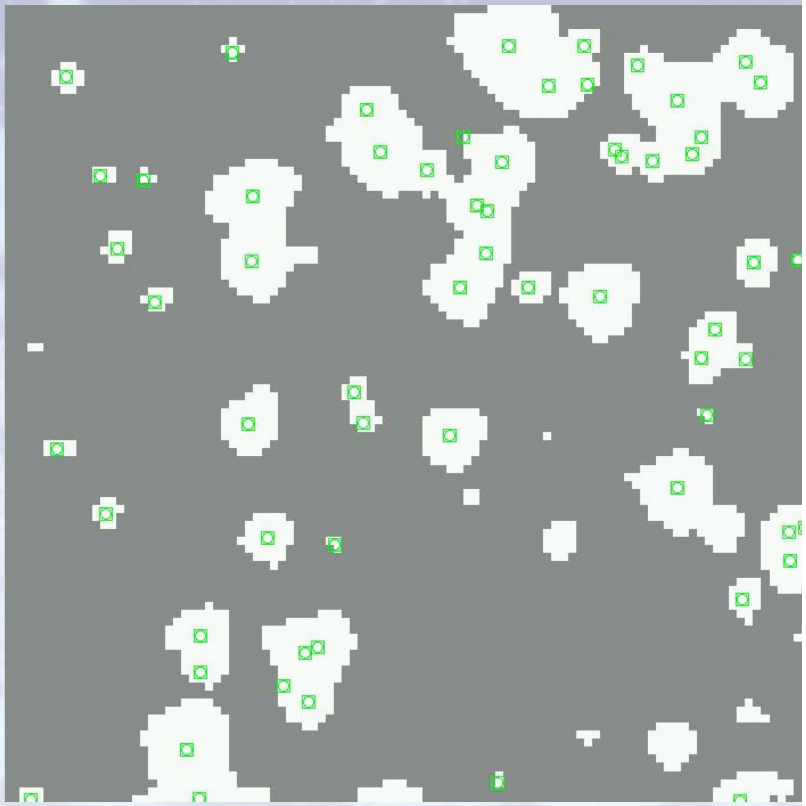




Implementation

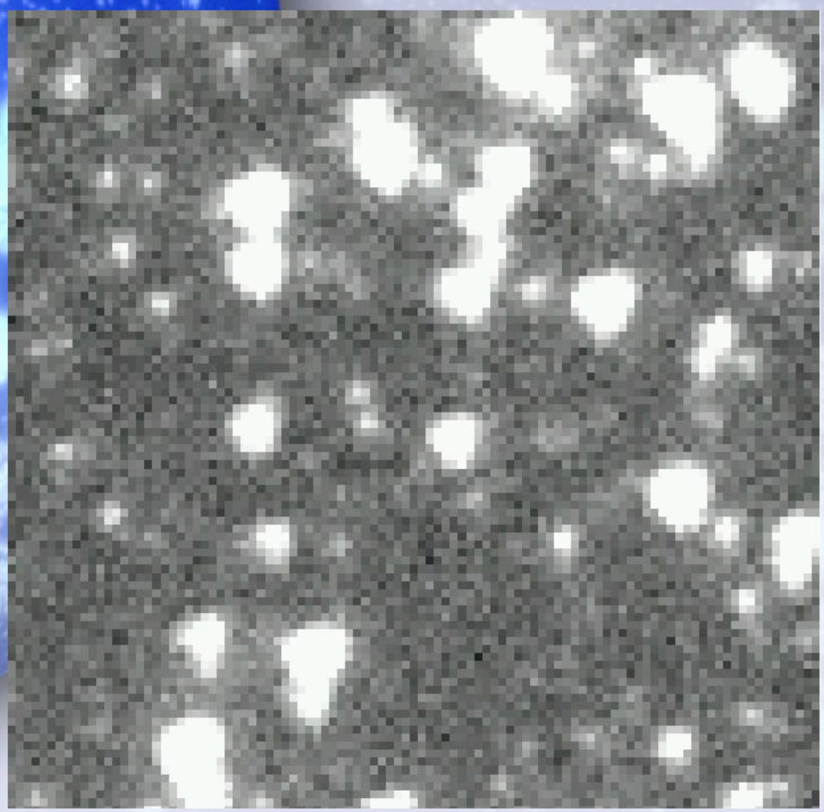
2. For each low-res detection, identify all sources from high-res catalog that lie within segmentation region

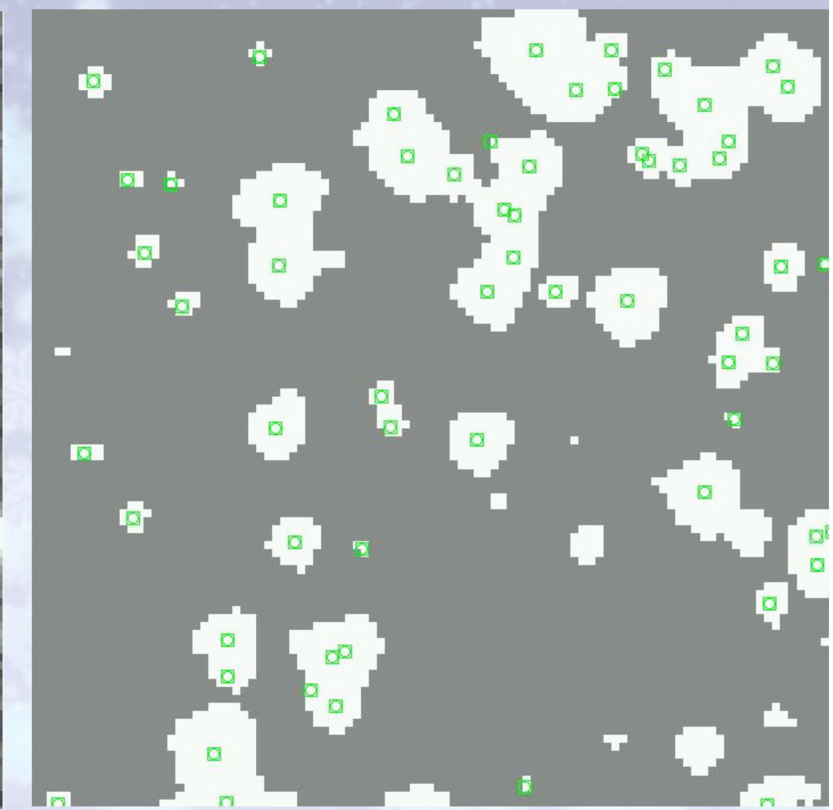




Implementation

3. For each low-res detection, construct models for each high-res object in segmentation region and convolve each model with PSF.





Implementation

4. Run minimization
   1. Simultaneous fit to all objects in segmentation region
   2. Magnitude is free parameter
   3. x,y are constrained free parameters for each object; can also be linked if desired.

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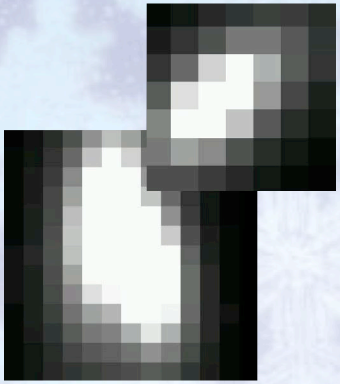

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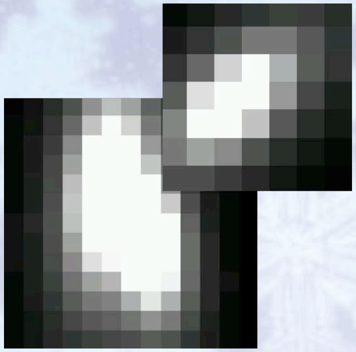
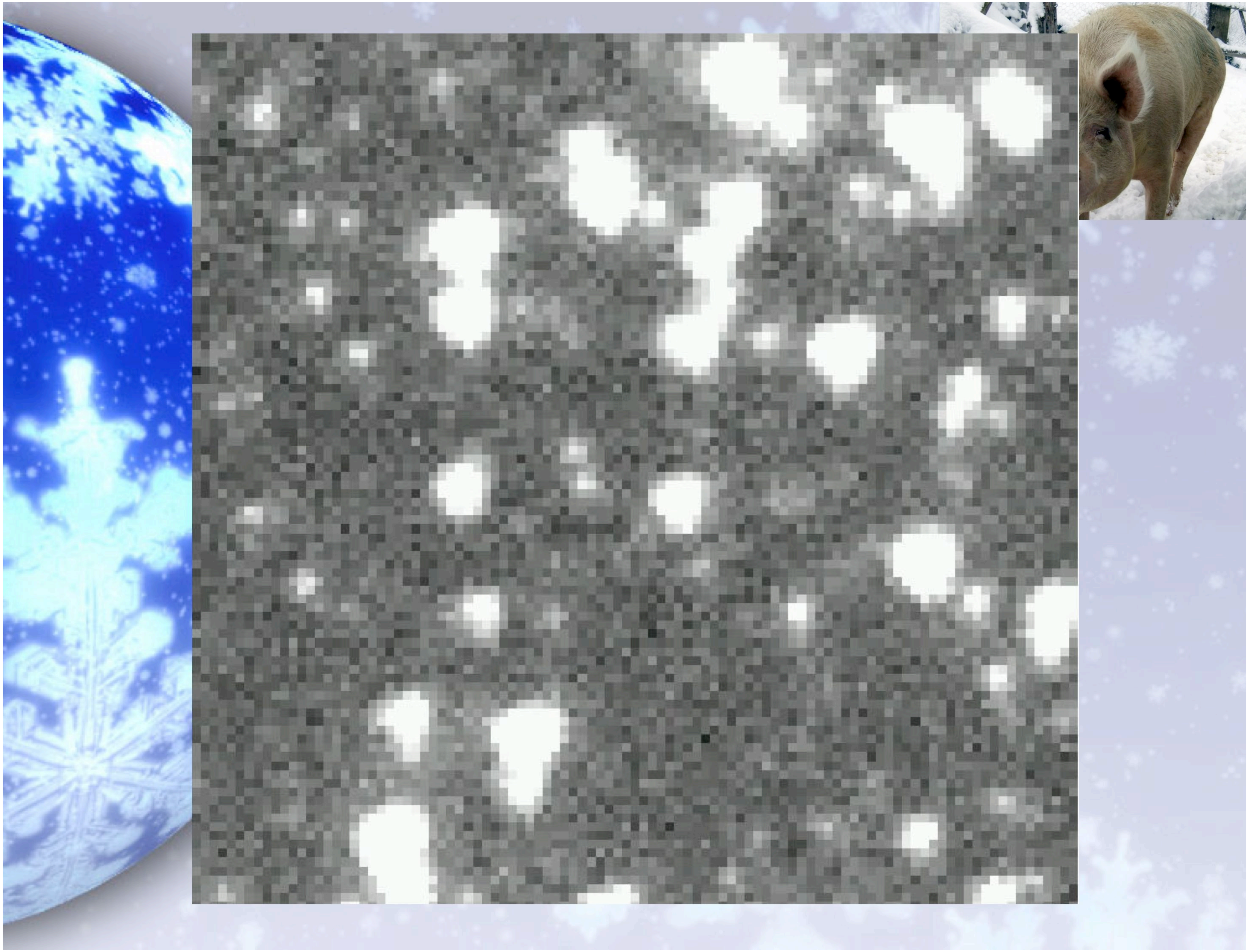
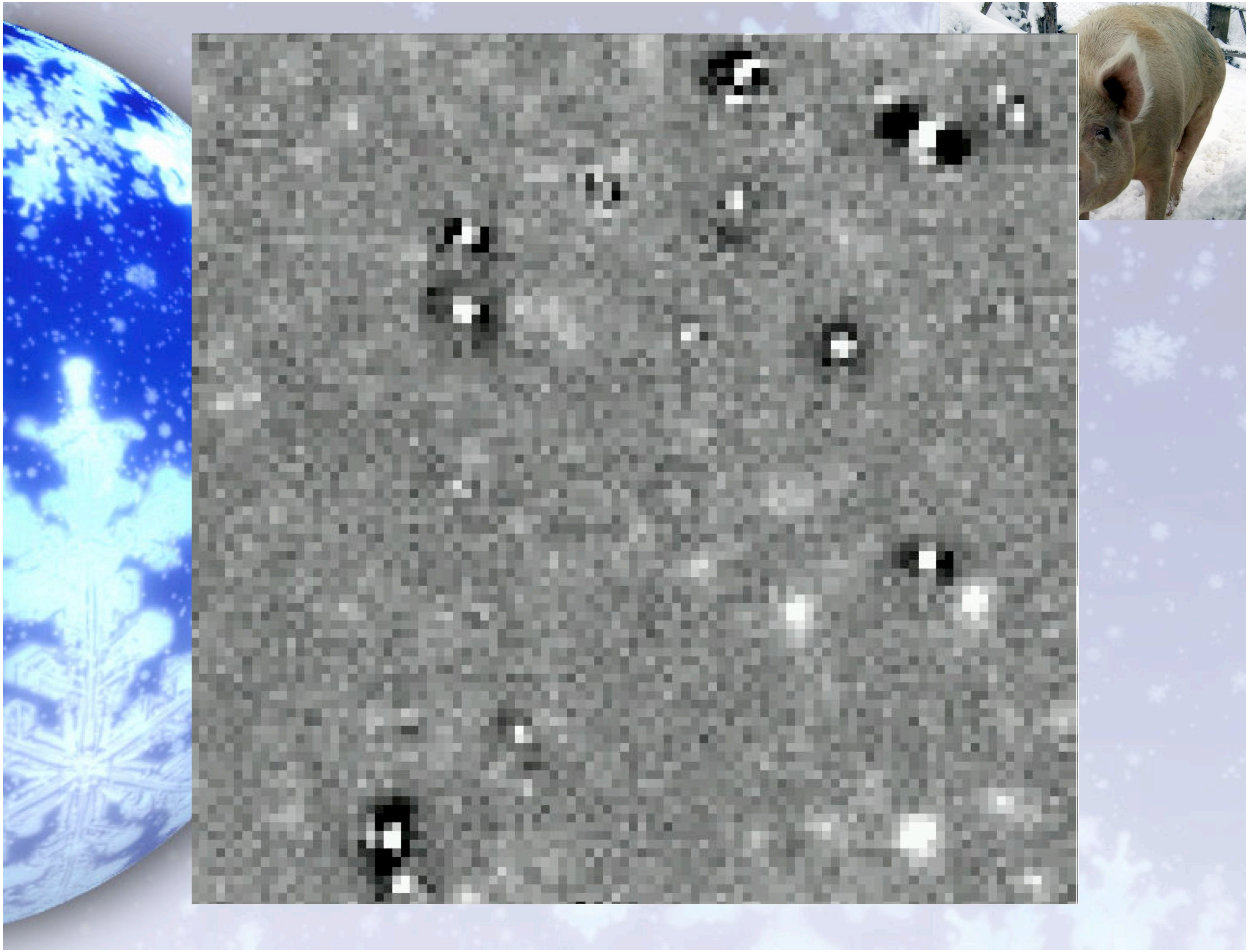
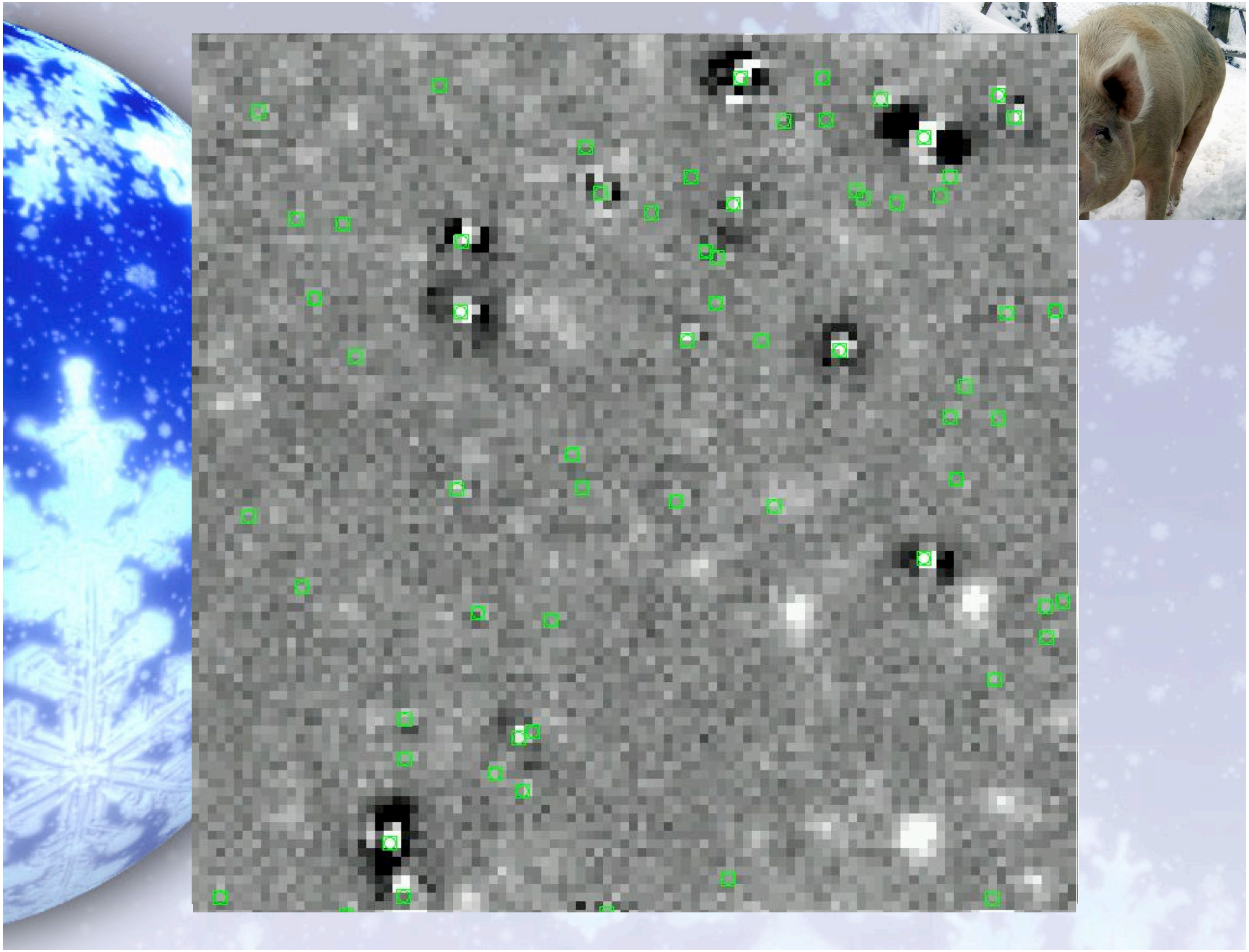






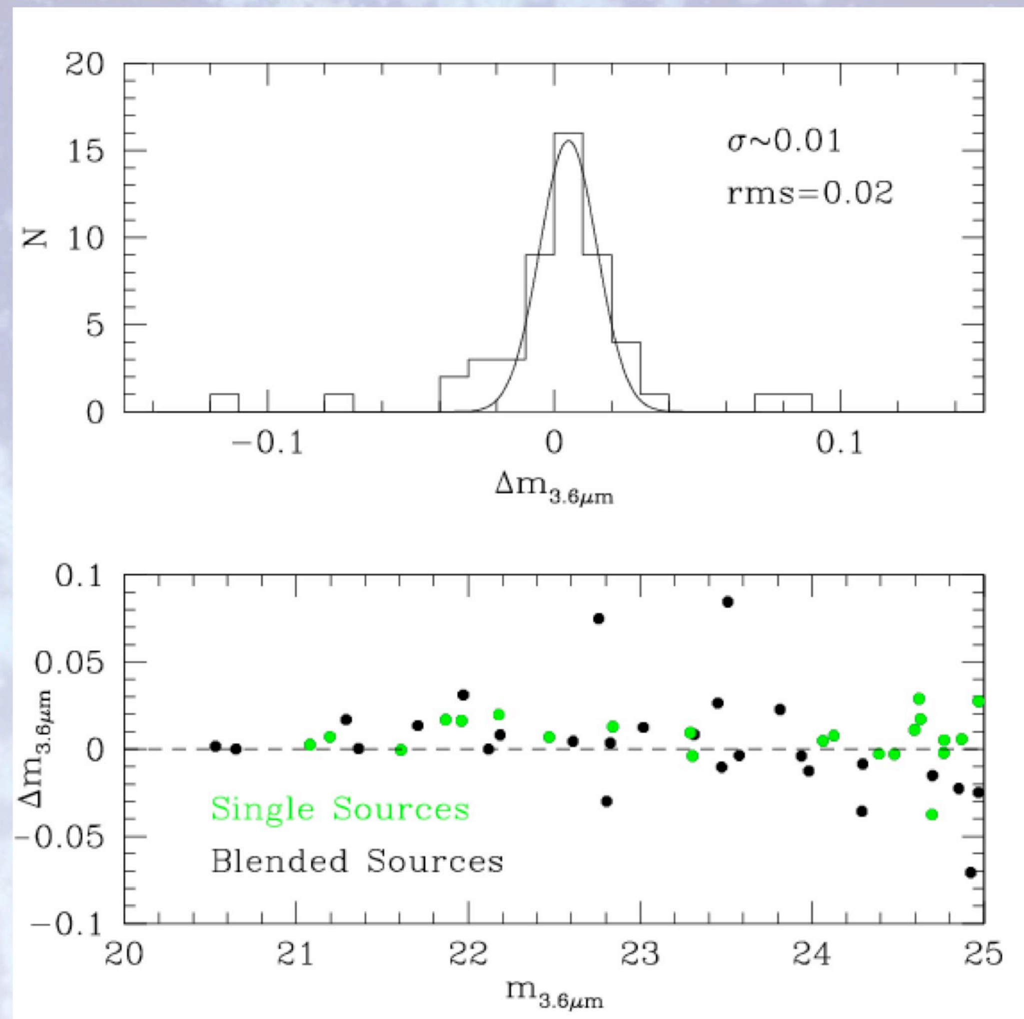


Sensitivity to PSF

<u>GOODS IRAC Comparison</u>

- Empirical vs SSC PSF
    - Consistent results for 94% of sources
    - RMS scatter of 0.02 mag between two input PSFS
- Use of random star in field as PSF:
    - RMS scatter of 0.06 mag
    - Consistent results for 91% of sources

Results not strongly dependent upon input PSF.



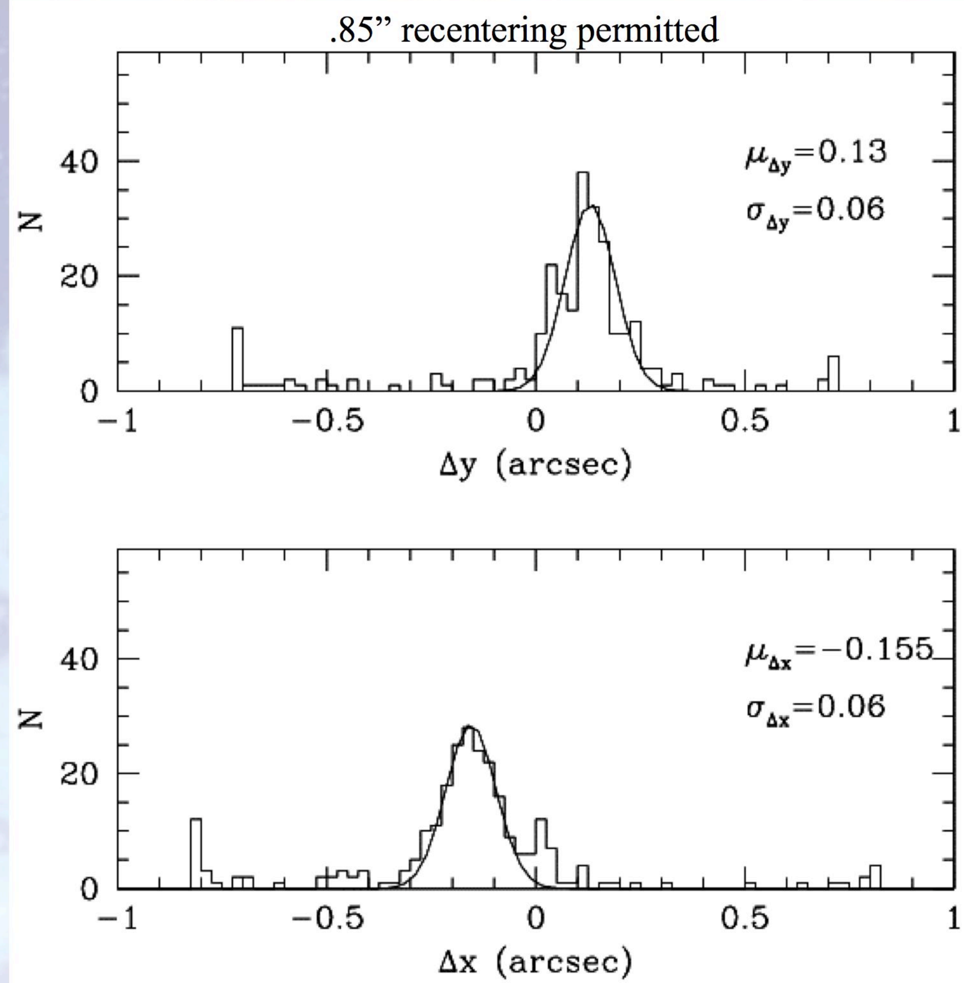
Stability to X,Y Jitter

Allowing X,Y to vary independently for each ACS source:

Solutions robust to translational freedom

Typical astrometric scatter in solutions for GOODS IRAC+ACS data is 0.06’’ along each axis

Few % drift to boundaries of permitted recentering.



Initial Science?

- Code currently in alpha testing
- Upcoming
  - GOODS Comparisons
  - Bullet Cluster (see also M. Bradac's talk)
  - IRAC Shallow Survey Galaxy Clusters at z=1-1.5 (see M. Brodwin's talk)